Materiel Solutions to Spatial Disorientation

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Outline

- Failure of Non-Materiel Solutions
- Materiel Solutions
  - Multisensory Cueing
  - Pilot Selection
  - Modeling to monitor pilot performance
- Requirements
- Demonstrations

SD Mishap Cause and Recommendations

- "Pilot failed to perform a proper scan of the instruments"
- "Pilot failed to respond in a timely manner"
- TTP – Tactics, Techniques and Procedure

  -- easy to propose, non-materiel, inexpensive but effects have long plateaued and have not ce...

Mission Needs Statement

- Quote from N-81 Requirements Document
- “Due to significant losses by all services in the past, the various safety centers have encourage operational activities to implement changes in doctrine, procedures and training to reduce the likelihood of loss of situational awareness. Despite reductions mishaps continue” --- Recognizes the need for ICONS

Army DVE program -- subset of SD

- 3 legged stool approach

  -- Automation – minimize pilot in-the-loop

  -- Sensors – see through the obscurance (dust, rain, snow)

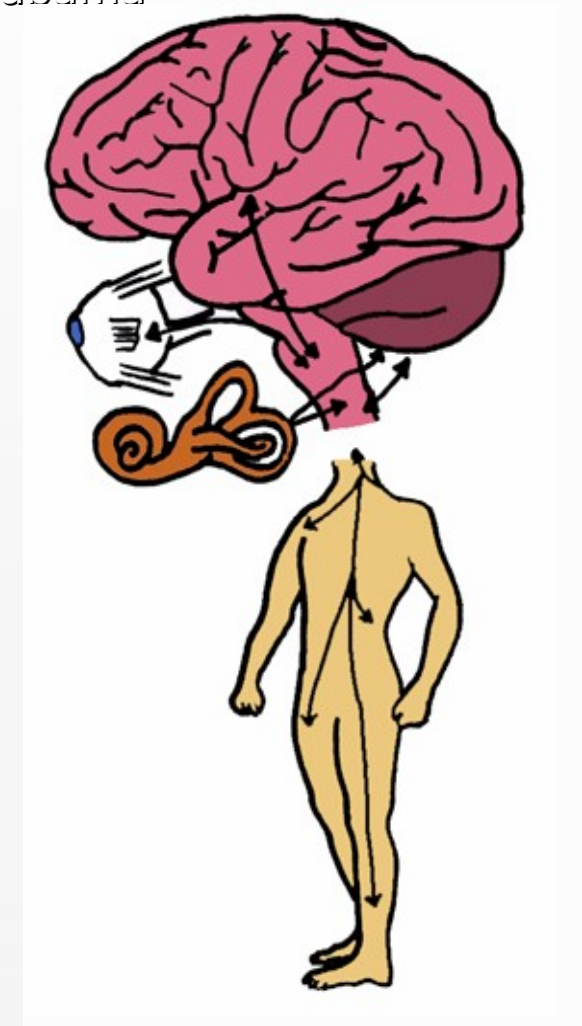
  -- Cueing – symbology term replaced to include tactile and 3D Audio. Recognition of multisensory cueing

DoD Report 2010

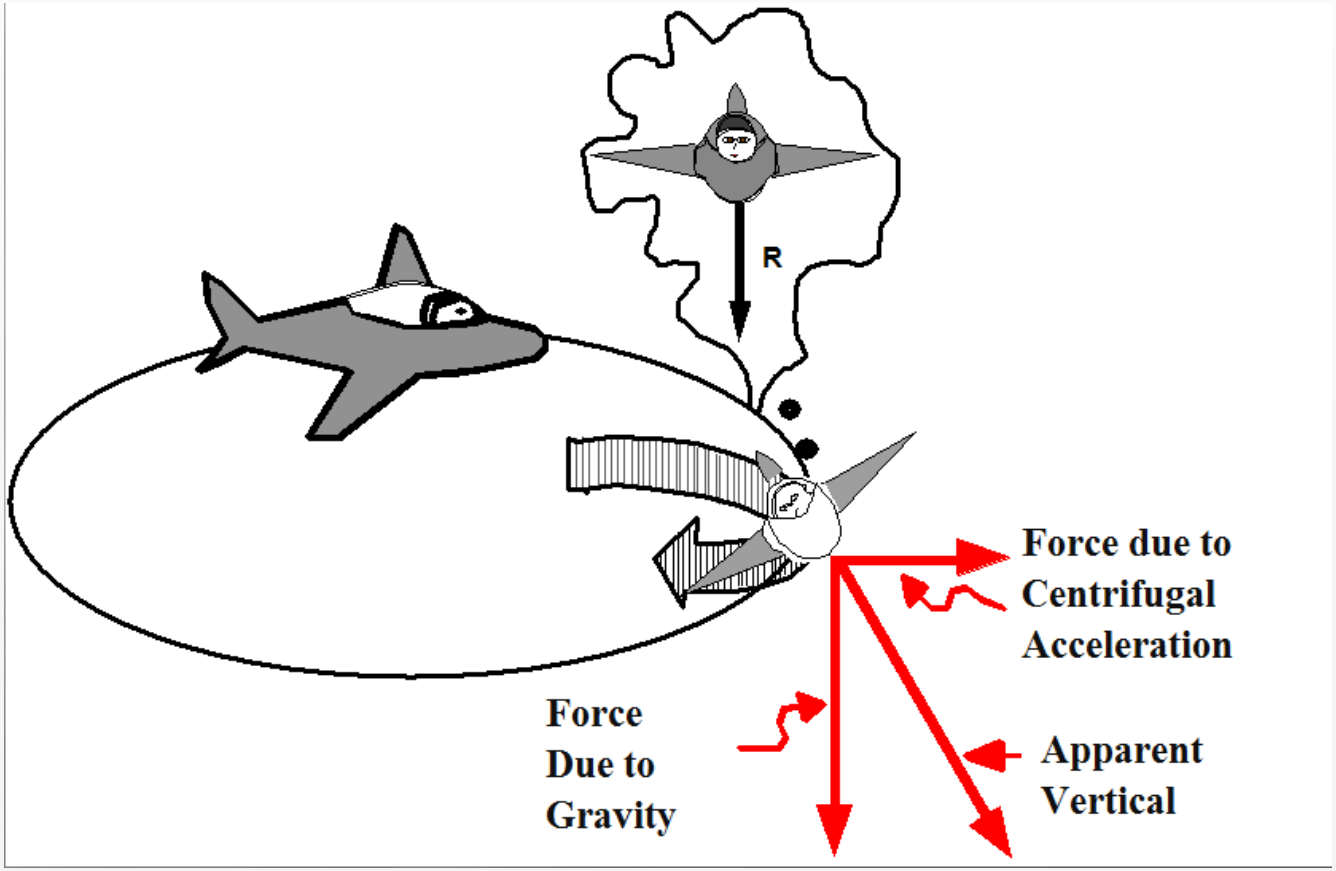
- Data from all safety centers
- For each helo lost to enemy action FOUR platforms are lost due to the environment.
- DEGRADED VISUAL ENVIRONMENTS

DVE IS OUR BIGGEST ENEMY

- **Army Safety Centre** – 2002 to 2013 - 25% Class A&B mishaps are DVE but account for 46% fatalities

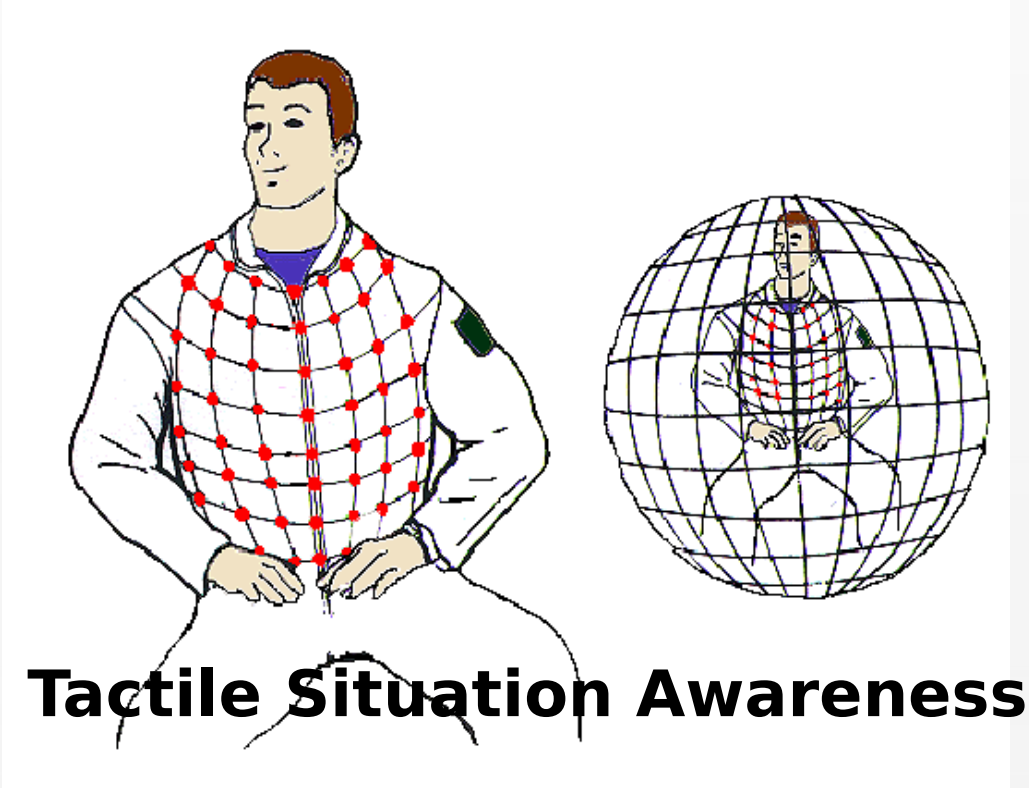


Resultant Accepted as Vertical



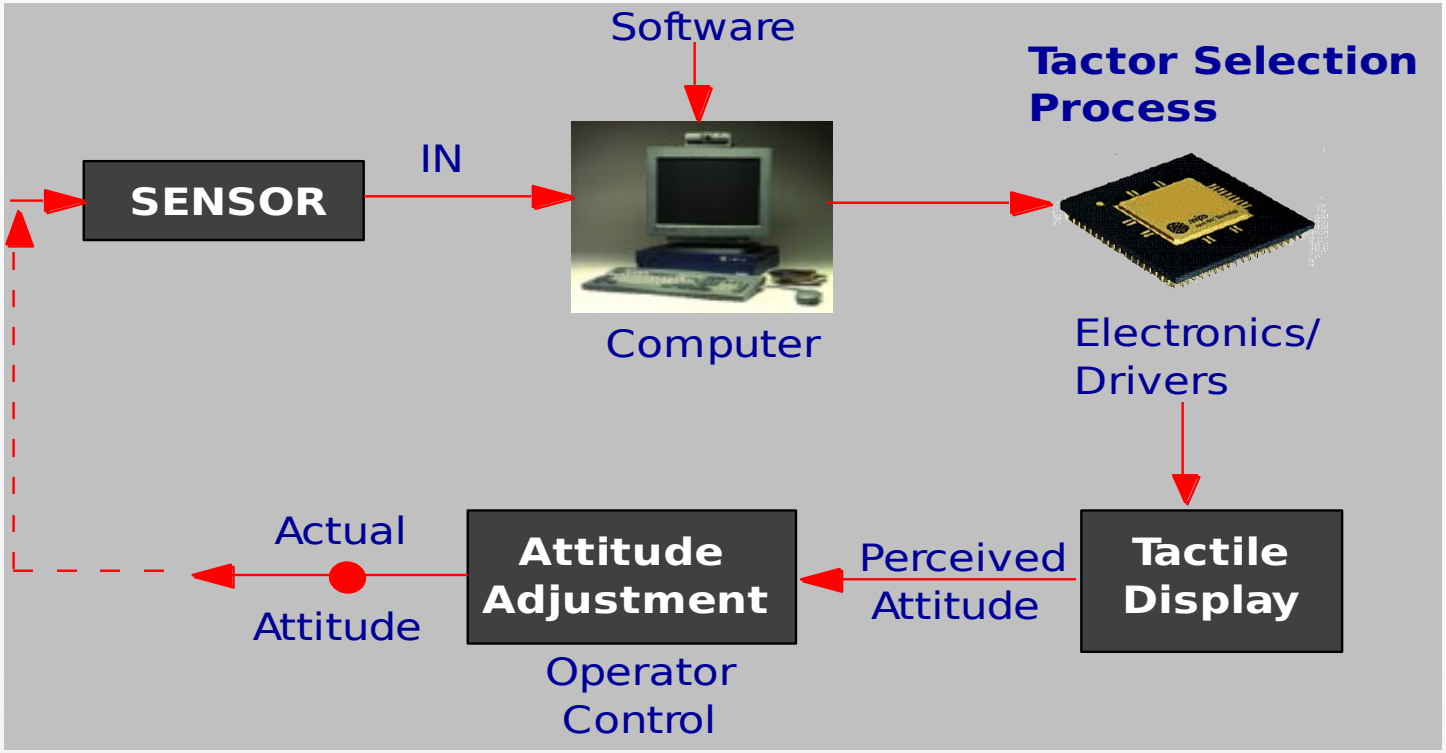
Bob Hoover

Solution --- Continuous Orientation Information

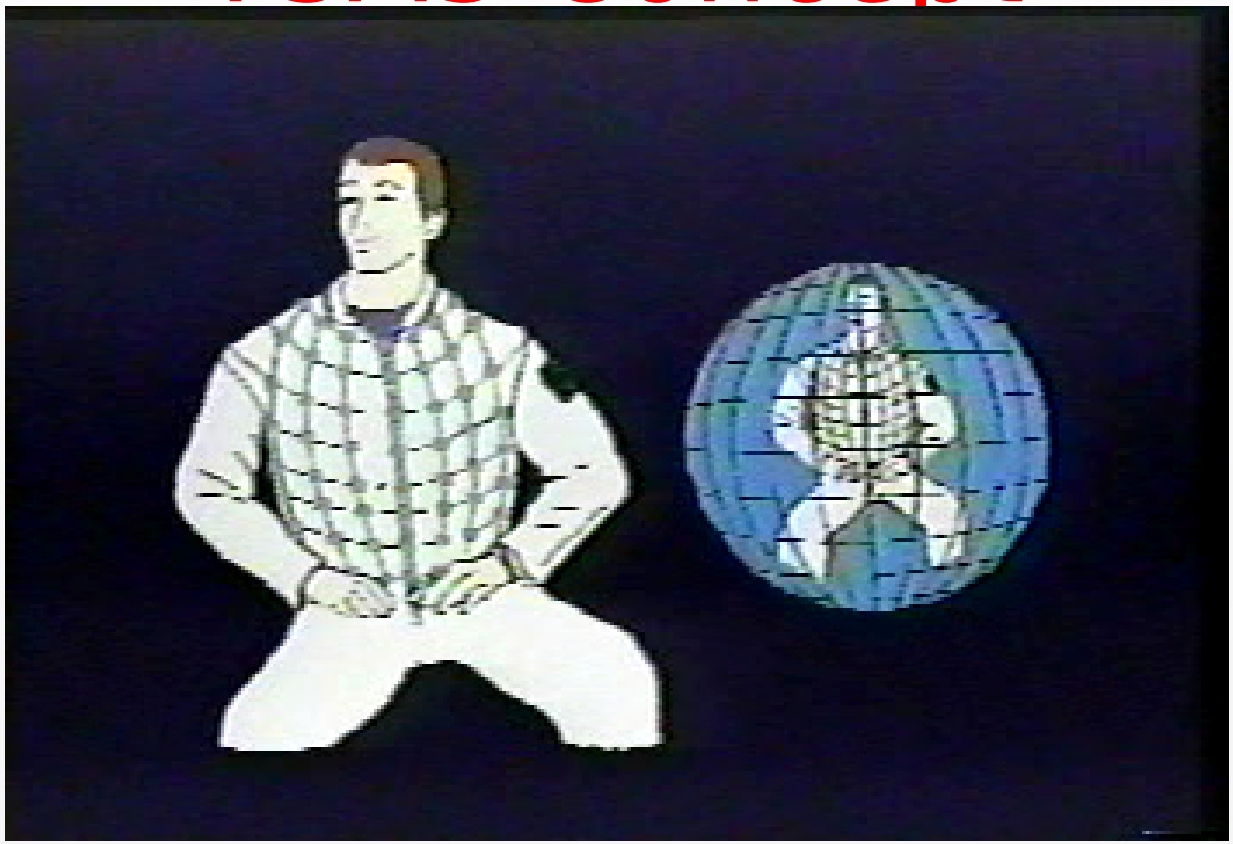


Tactile Situation Awareness System

Tactile Display System



TSAS Concept



T-34 Flight Demonstration

NAS Patuxent River, MD

Hover NVG Gen Mangum Oct 2011

Requirements & Testing

- Aircraft Survivability ICD
- Air Soldier System CDD

  -- Tactile Cueing
- UHPO Utility test AATD April 2014

  -- July Test Report recommend continued development H-60 M

MAJ Joe Davis

Pilot Selection as it relates to SD

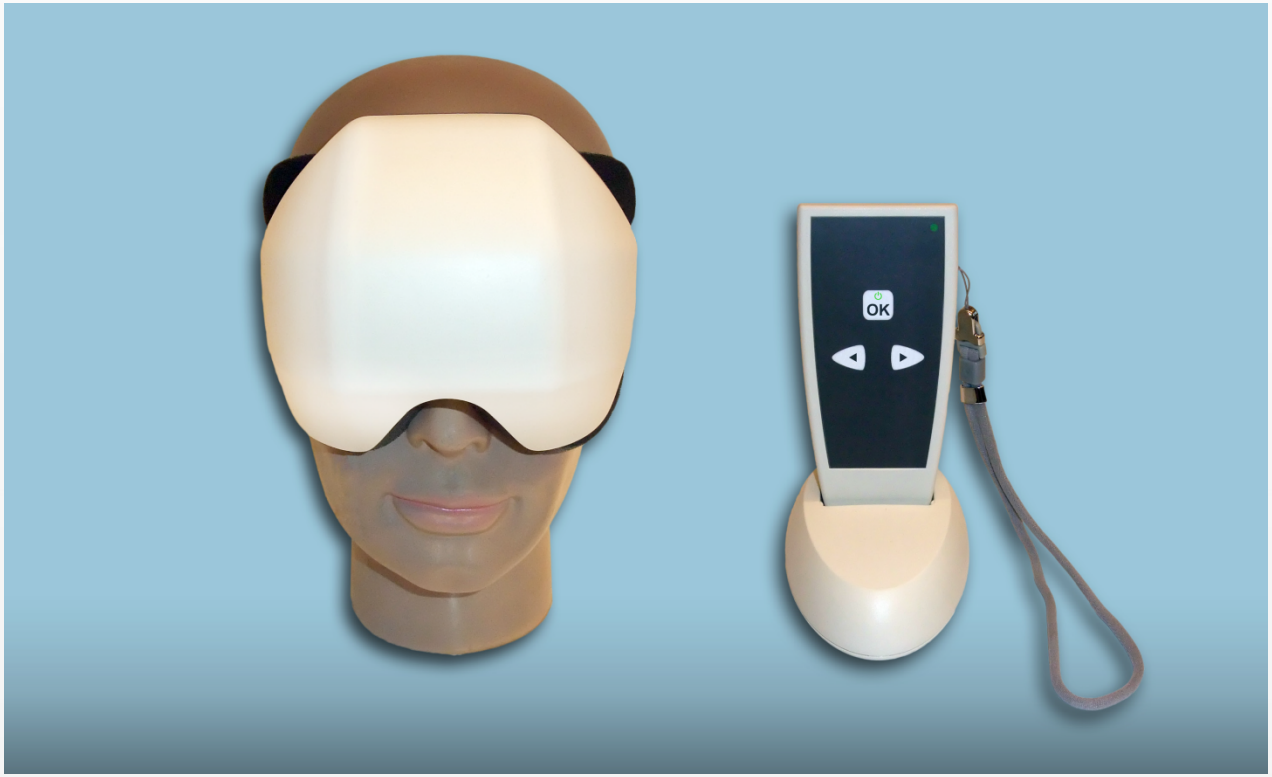
- Well defined selection standards for Vision and Hearing standards do not exist for vestibular special sense. Why?
- Measurements are still non specific and without set aviator standards.

Neurokinetics Chair

Neurokinetics Test Device

- 100 units exist across country to include many military bases now that recognition of vestibular/balance issues are closely associated with mTBI.
- System developed in Pensacola – NAMRL
- New SBIR to provide several tests with one simple head-mounted

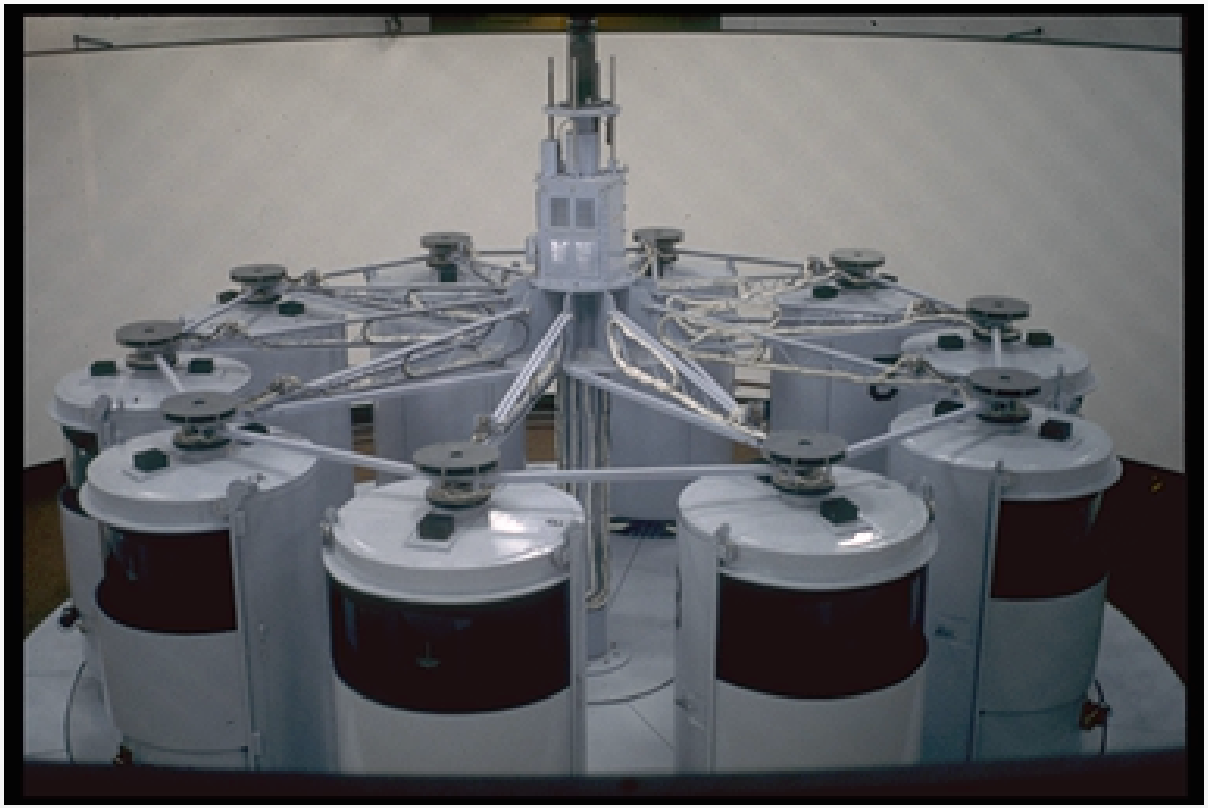
SVV -- expandable

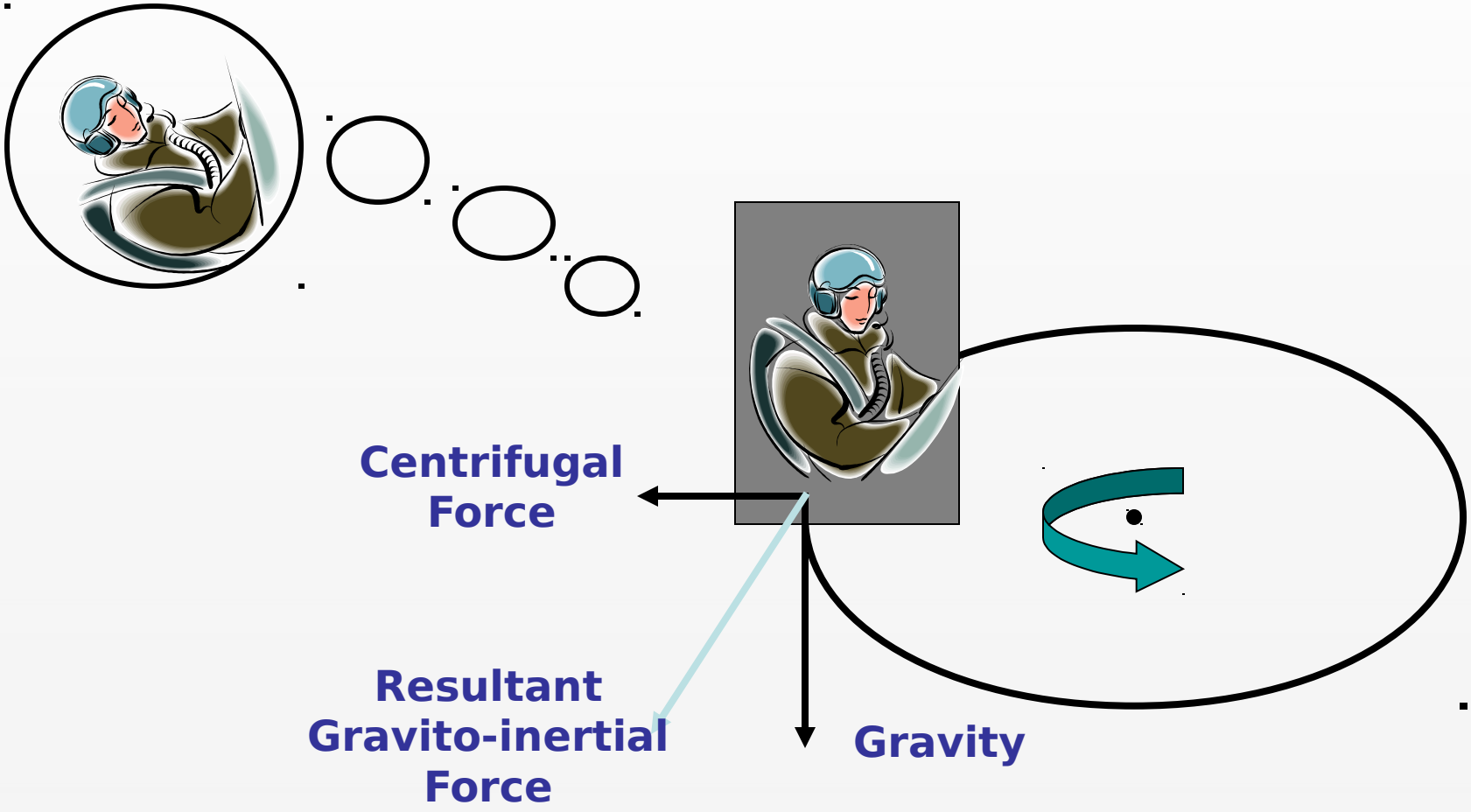


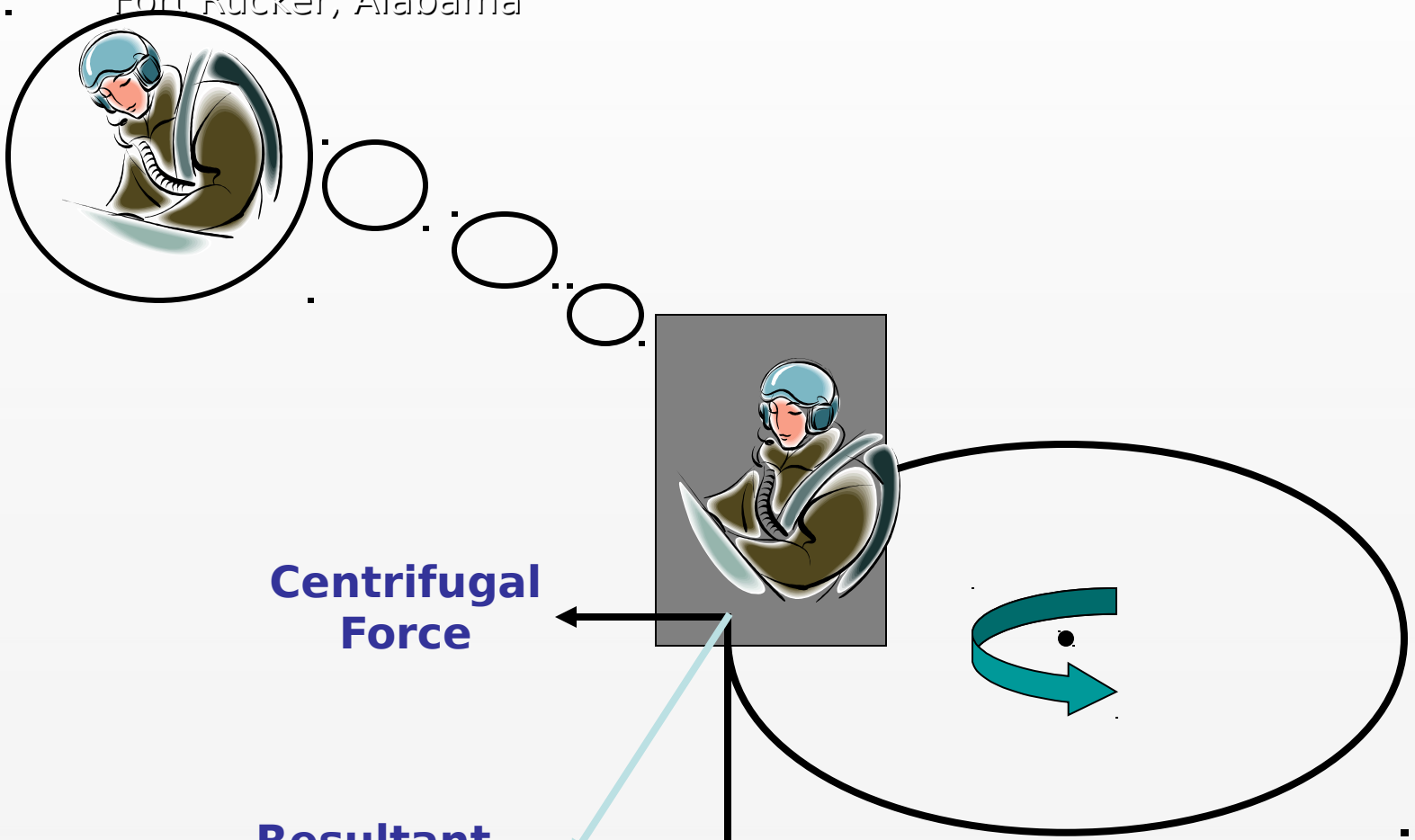
Vestibular Test Battery– Aviation

- Need for acceleration forces to provide stimuli similar to in-flight conditions
- Maintained linear acceleration requires special devices

Multi Station Disorientation Demonstration Device MSDD




Centrifugal Force
Resultant Gravito-inertial Force
Gravity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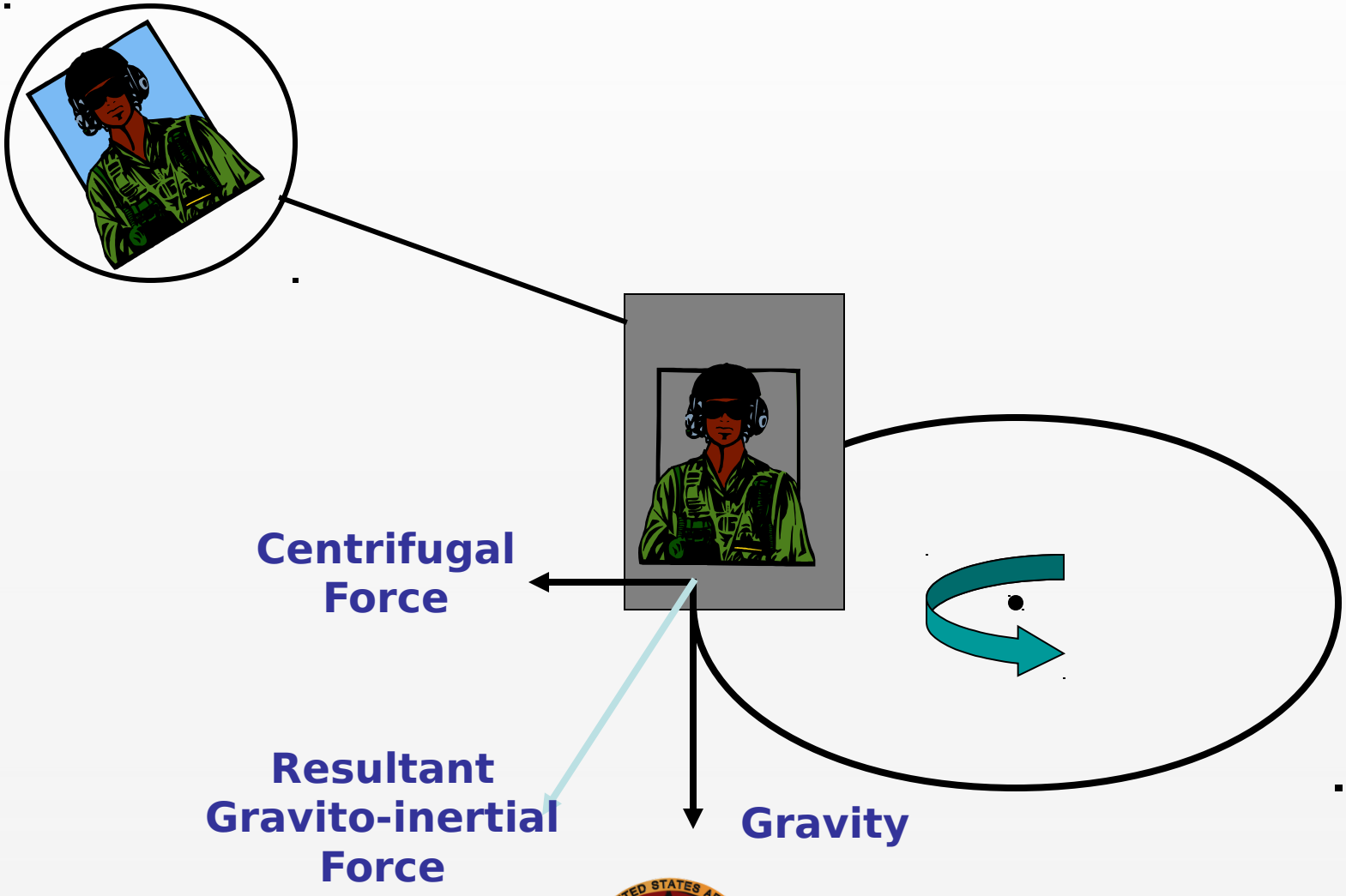
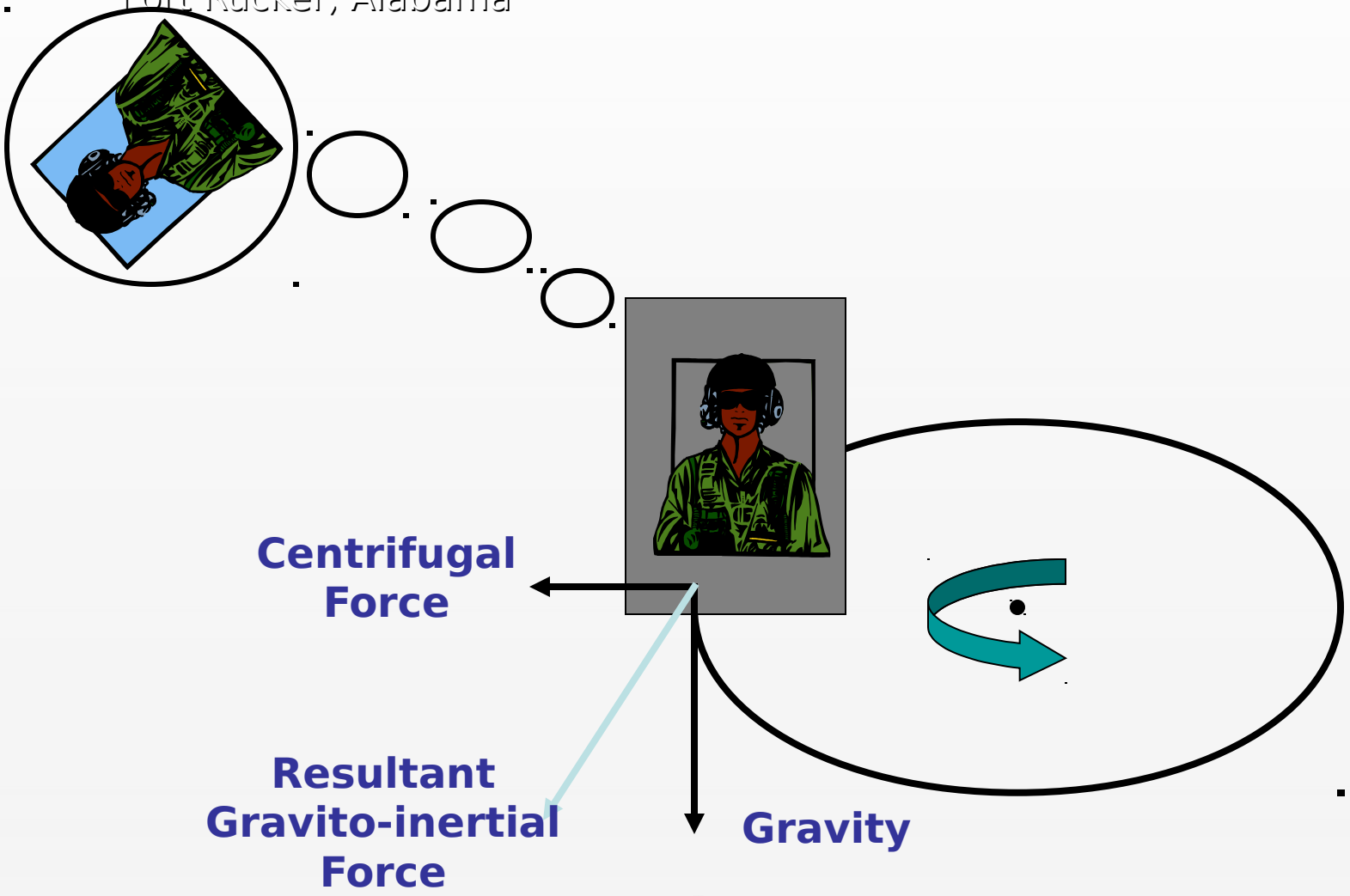
Resultant Gravito-inertial Force
Gravity


Centrifugal Force
Resultant Gravito-inertial Force
Gravity


Centrifugal Force
Resultant Gravito-inertial Force
Gravity

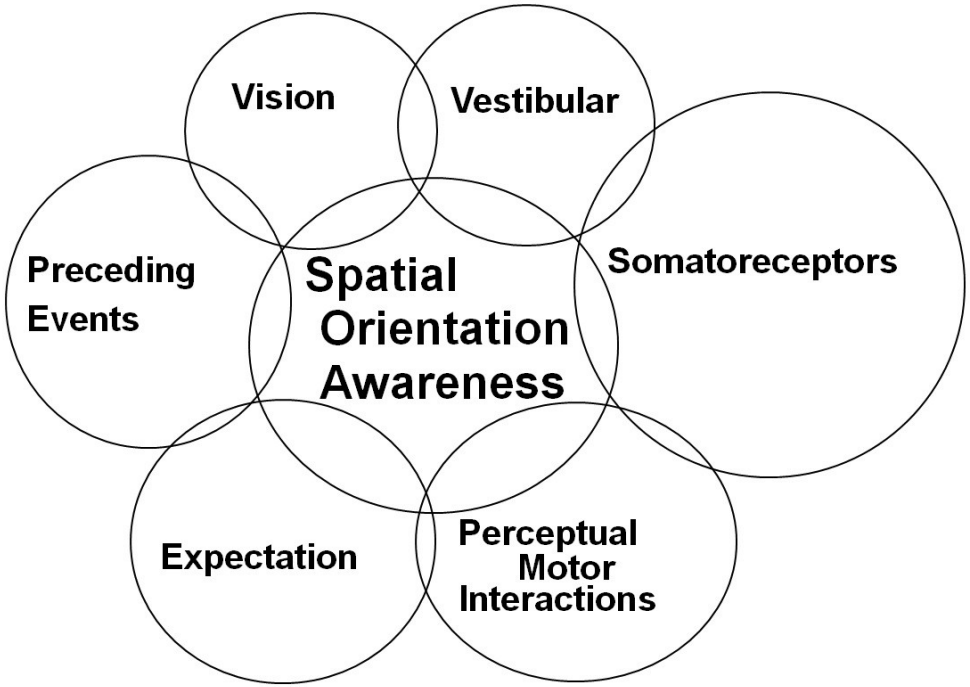
Modeling of Pilot Perception

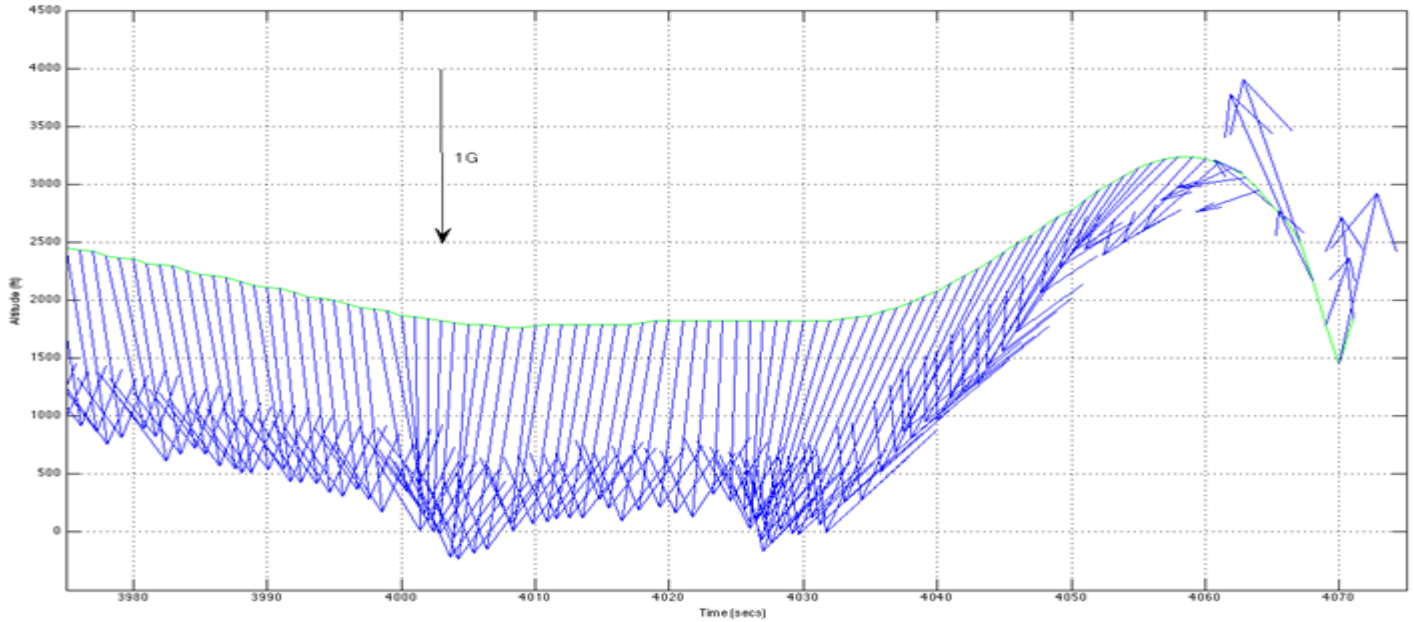
- Used in mishaps analyses since 1996
- Simplest mishap causing greatest fatalities is a form of somatogravic – distraction and slow deviation with one G could be solved either by TSAS or perception model with eye gaze equipment.

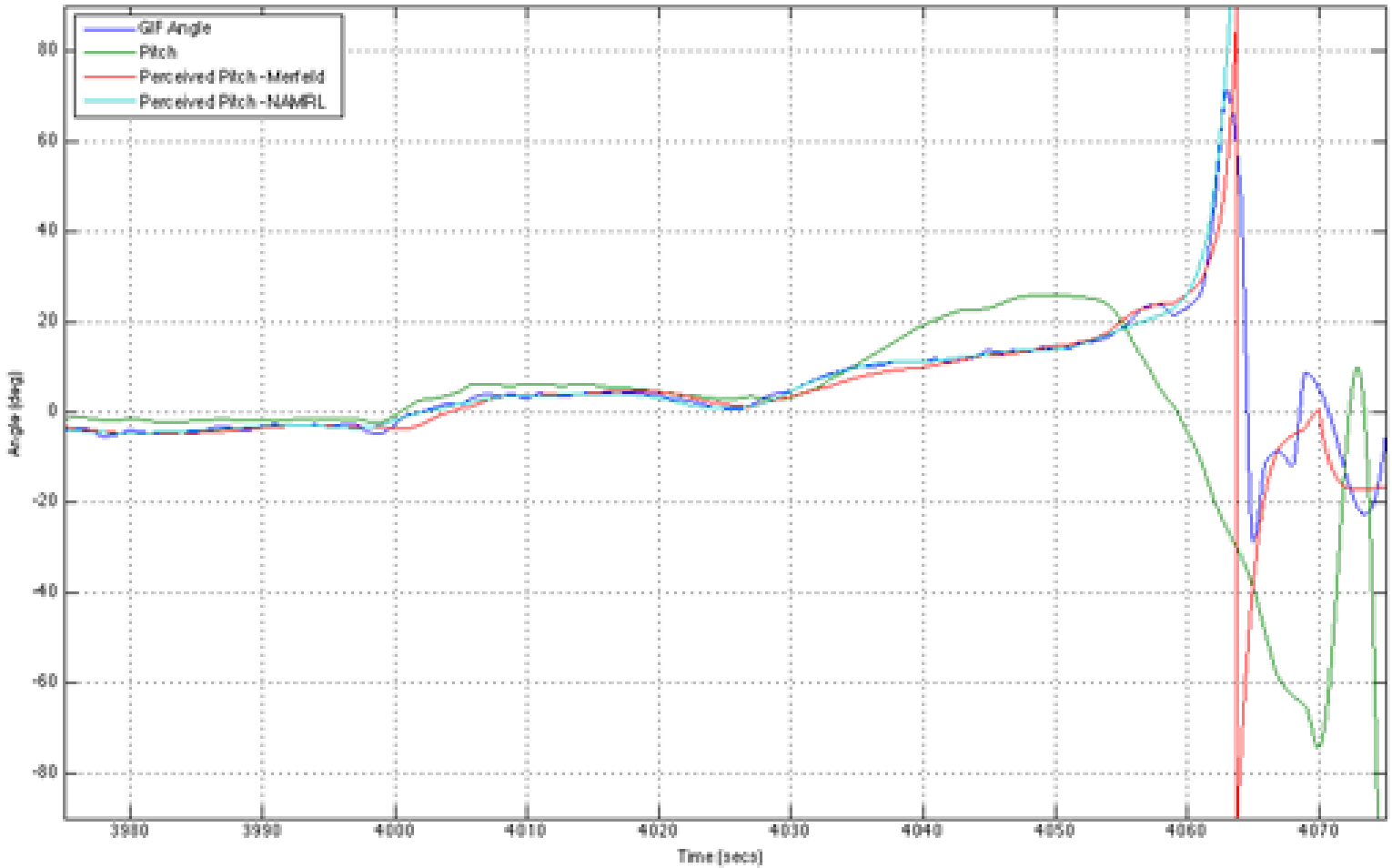
Mishap Modeling

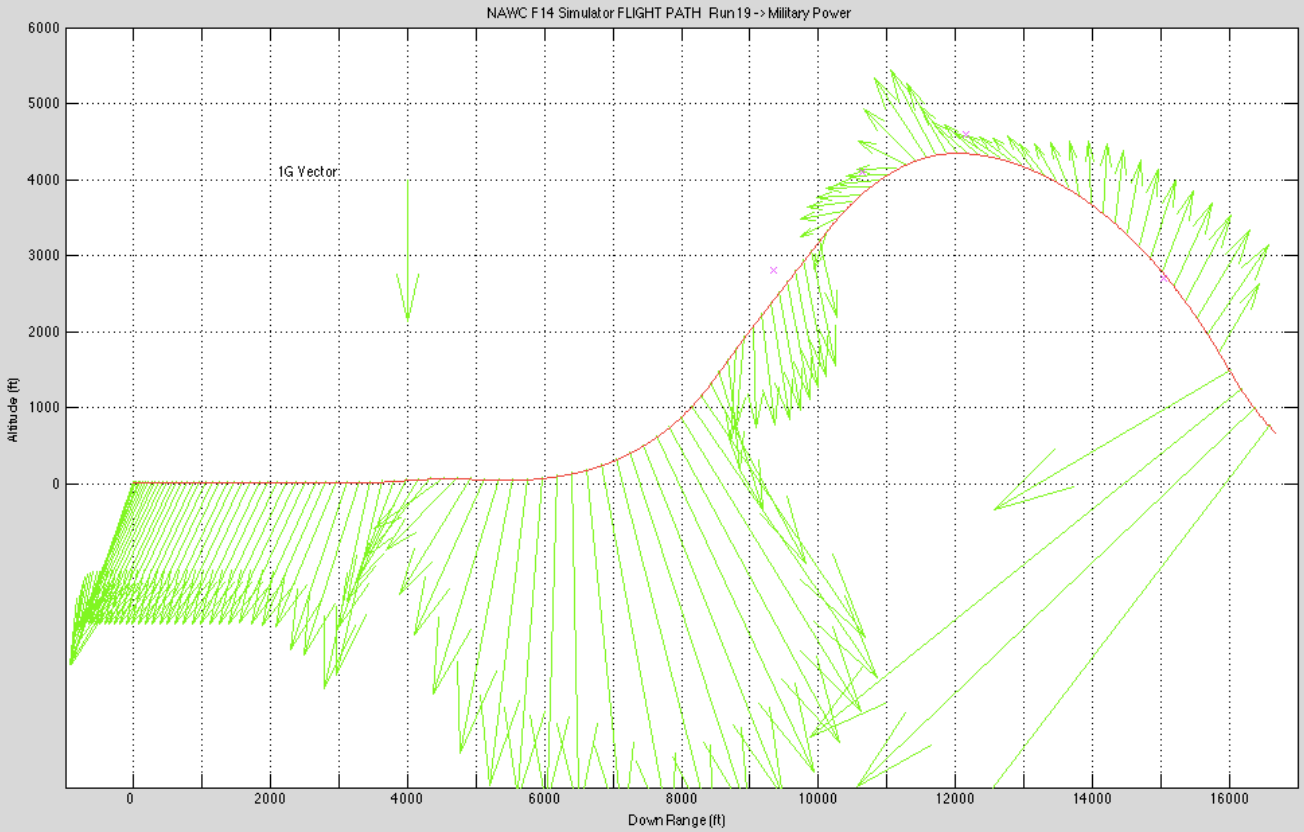
- NTSB referrals for perceptual analysis every 18 – 24 months with typical somatogravic illusion.
- Model is refined with black box information from mishaps and experimentation to extend the envelope of knowledge

Complexity of Problem




1G
Altitude (ft)
Time (secs)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
3980
3990
4000
4010
4020
4030
4040
4050
4060
4070


GIF Angle
Pitch
Perceived Pitch - Merfeld
Perceived Pitch - NAMRL
Angle [deg]
Time [secs]
80
60
40
20
0
-20
-40
-60
-80
3980
3990
4000
4010
4020
4030
4040
4050
4060
4070


NAWC F14 Simulator FLIGHT PATH Run19 -> Military Power
1G Vector
Altitude (ft)
Down Range (ft)
6000
5000
4000
3000
2000
1000
0
0
2000
4000
6000
8000
10000
12000
14000
16000

BEA (NTSB in France)

- *"Study on Aeroplane State Awareness during Go-Around"* – August 2013
- Increasing number of mishaps related to somatogravic type illusion over past 20 years

  -- increased engine performance

  -- pilot and especially co-pilot workload
- Material solutions exist to prevent these

Summary -- Materiel Solutions

- Army CRC claims 12% Class A (and half of all fatalities) could be prevented with tactile cueing – experience DEMO in lobby
- Selection – unknown how many pilots
- Modeling with automation to remove the most faulty platform component from the loop – the PILOT.

The New Norm

Firescout MQ-8
& UCAV X-47B

Questions

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Demo Tactile Cueing

Perceived
Actual
Cockpit view
Not actual conditions
Day view intended to show aircraft relative position only
Actual Pitch, Perceived Pitch
Actual Roll, Perceived Roll
Time to Impact
70.0
G Meter
(NOT IN AIRCRAFT)
Start
Stop
1000
NAMRL 2005

TSAS
Tactile Situation Awareness System